Rapid Method for Classification of Cheddar Cheese Based on Flavor Quality Using Infrared Spectroscopy

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ABSTRACT

Analysis of Cheddar cheese flavor using human taste panels is expensive and time consuming. A rapid and simple instrumental method based on Fourier transform infrared spectroscopy was developed for classifying Cheddar cheese based on flavor quality. Fifteen Cheddar cheese samples from two different commercial production plants were ground into powders using liquid nitrogen. The water-soluble compounds from the cheese powder, without interfering compounds such as complex fat and protein, were extracted using water and organic solvents. Aliquots (10 µL) of the extract were placed on the sampling accessory, dried and scanned in the spectrometer (4000 to 700 cm^{-1}). The spectra were matched with the flavor quality to build statistical classification models. The models provided 3D plots in which all the 15 cheese samples formed well separated clusters, whose orientation correlated well with their cheese flavor characteristics (fermented, unclean, low flavor, sour, good cheddar, etc.). The discrimination of the samples was mainly due to organic and fatty acids and their esters (1500 to 900 cm^{-1}), which are known to contribute significantly to cheese flavor. The total analysis time, including the sample preparation time, was less than 20 min per sample. This technique can be a rapid, inexpensive, and simple tool to the cheese industry for predicting the flavor quality of cheese.

INTRODUCTION

About 9.13 billion pounds of cheese is produced in the US every year, of which 34% is cheddar cheese. Flavor quality of cheddar cheese significantly influences its consumer acceptance, price and food processing application. Cheese flavor is directly affected by the physical, chemical and microbiological changes that occur during ripening (aging). Cheese flavor is currently determined using trained human tasting panels. This process is time consuming and very expensive. Predicting the flavor quality of cheese using instrumental methods can save time and money for the industry. However, heterogeneous composition of cheese make it difficult to develop rapid and reliable instrumental methods for flavor quality analysis.

Fourier transform Infrared (FT-IR) spectroscopy, which utilizes the light absorbing properties of chemical compounds, can be used as a rapid, inexpensive, and sensitive method to analyze cheese flavor. Unlike many chromatographic techniques, FT-IR spectroscopy provides unique overall chemical fingerprints (spectra) of cheese samples. FT-IR spectra can be analyzed through multivariate statistical techniques to rapidly discriminate Cheddar cheese based on flavor.

OBJECTIVE

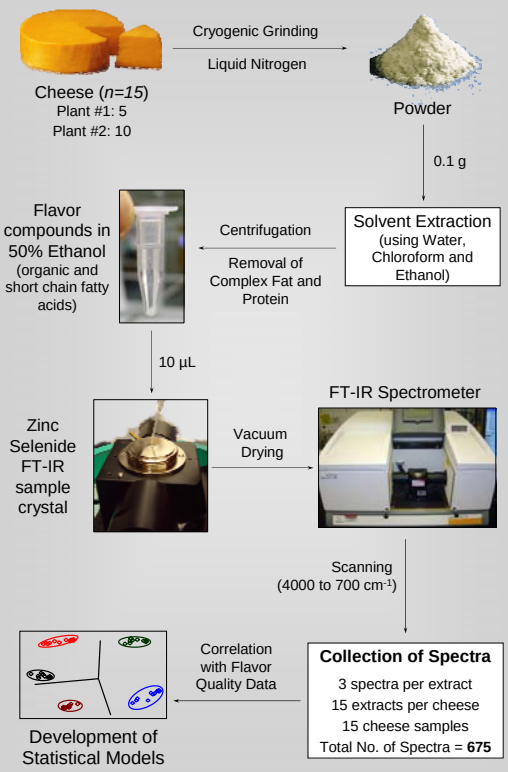
The objective of this research was to develop a rapid and simple technique based on FT-IR spectroscopy to predict the flavor quality of Cheddar cheese.

SIGNIFICANCE

A rapid instrumental method for cheese flavor quality analysis will

- Save time and money for the cheese industry
- Enable better quality control
- Provide better control over the ripening process to achieve cheese of desired flavor quality
- Initiate and accelerate further studies on the cheese ripening process using spectroscopy

METHODOLOGY



RESULTS

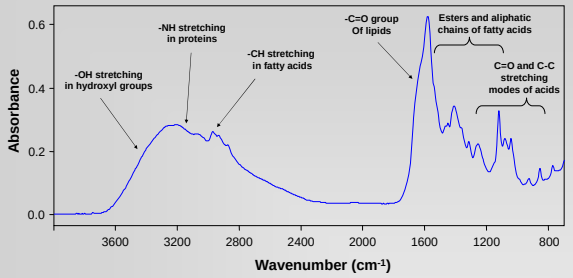


Fig 1. Typical FT-IR Spectrum of Cheddar Cheese Extract

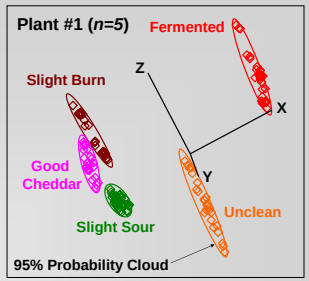


Fig 2. 3D Classification Model for Plant #1

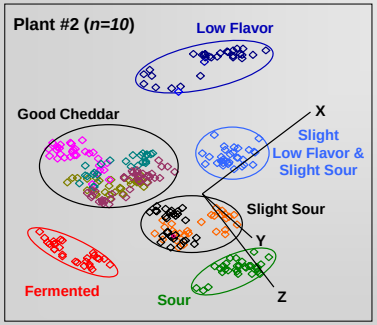


Fig 3. 3D Classification Model for Plant #2

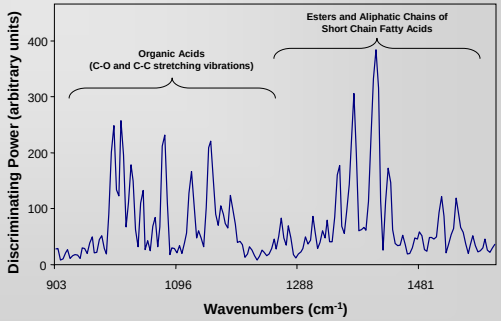


Fig 4. Spectral Regions Responsible for Classification

DISCUSSION

- The developed extraction method yielded cheese extracts whose FT-IR fingerprints were well defined, unique for each sample and very consistent (**Fig 1**).
- All the 5 samples from **Plant #1** formed distinct clusters in 3D space (**Fig 2**). **Fermented** and **Unclean** samples clustered far from the good and better samples (**Good**, **Slight Burn** and **Slight Sour**).
- Samples from **Plant #2** also formed clusters whose orientation correlated with their flavor. The **Fermented**, **Sour** and **Low Flavor** samples clustered away from the **Good Cheddar** (**Fig 3**). Samples with multiple attributes (**Slight Low Flavor & Slight Sour**) clustered in between **Sour** samples and **Low Flavor** samples.
- The discrimination of the samples was due to organic and fatty acids and/or their esters (900 to 1500 cm^{-1}), which are known to contribute significantly to Cheddar cheese flavor (**Fig 4**).
- The total analysis time, including the sample preparation time, was less than 20 min per sample.

CONCLUSIONS

- The developed sample preparation method and FT-IR technique show great potential as a rapid, inexpensive, and simple quality control tool for determination of flavor quality of cheese.
- Preliminary experiments with Swiss cheese provided similar results. Therefore, this method has potential to be applied to other types of cheese.

REFERENCES

- Rodriguez-Saona, L.E., Koca, N., Harper, W.J., and V.B. Alvarez. 2006. Rapid determination of Swiss cheese composition by Fourier transform infrared/attenuated total reflectance spectroscopy. *J. Dairy Sci.* 89: 1407-1412.
- Chen, M., Irudayaraj, J., and D.J. McMahon. 1998. Examination of full fat and reduced fat Cheddar cheese during ripening by Fourier transform infrared spectroscopy. *J. Dairy Sci.* 81: 2791-2797.

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